BODY BUILD AND ITS INHERITANCE

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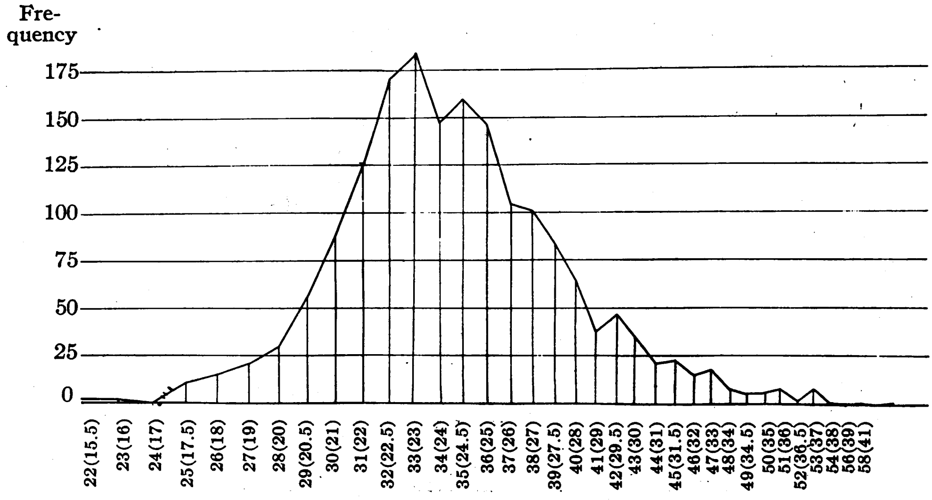
Body build is described by such adjectives as "slender," "medium," "fleshy," and "very fleshy." The current theory of the physiology of nutrition to account for these various types of build runs somewhat as follows. Whenever the number of calories of the ingested food exceeds the number required for basal metabolism, the extra work done and possible loss in ejecta the surplus is used in building material which adds to



Index of build, English, with metric in parenthesis

Logarithmic Curve of Build of 1750 Adults

FIGURE 1

Logarithmic curve of distribution of index of build of 1750 adults. Ordinates are proportional to frequency; abscissae to the size of index, increasing from left to right. The numbers in parenthesis give the index of build in French units; the other numbers in English units.

the body weight; or, if the calories are in deficiency, the deficit is made up by burning body tissue, resulting in loss of weight. In the first case the individual puts on weight; becomes fleshy or obese. In the second case he loses in weight and becomes slender.

A study of a considerable number of families leads to the conclusion that the nutritional theory is not complete. It suggests that there is a genetical difference in different families in the economy of fattening. In some families the individuals fatten readily; in others with difficulty.

Consequently with a given constant excess of calories some fatten very slowly; whereas others put on weight rapidly. The difference between families is something like that which exists between Aberdeen-Angus steers and Jersey steers. As Armsby showed, the former fatten more readily than the latter, both because they eat more and because their excess calories go to the building up of fat while in Jerseys it goes in a greater extent into the building of protein, and the protein is believed to cost more calories per pound to make. There is a difference in the metabolic processes in the two breeds. And humans differ genetically just as cattle do.

In the present investigation it was found simplest to measure build by the ratio chest girth divided by stature; i.e., relative chest girth.

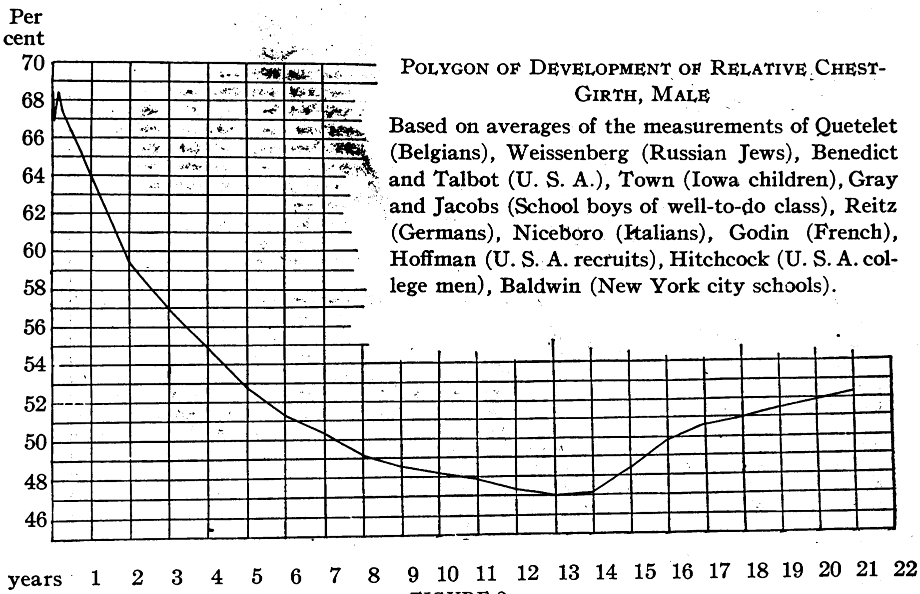


FIGURE 2

Curve of development of relative chest girth, males. Ordinates chest girth multiplied by 100, divided by stature. Abscissae, age in years.

However, if chest girths are not available the ratio weight ÷ stature² is used as an index of build. If a lot of adult males be measured it is found that the distribution of the indices of build is as indicated in figure 1. In any polygon of distribution of adult build there are always present two peaks, one of which lies slightly below and the other somewhat above the mean build. The mean build changes in the male from birth to maturity as indicated in figure 2. The relative chest girth at birth is 67%; falls to 47% at 13 years and rises to 52% at 22 years and probably continues to

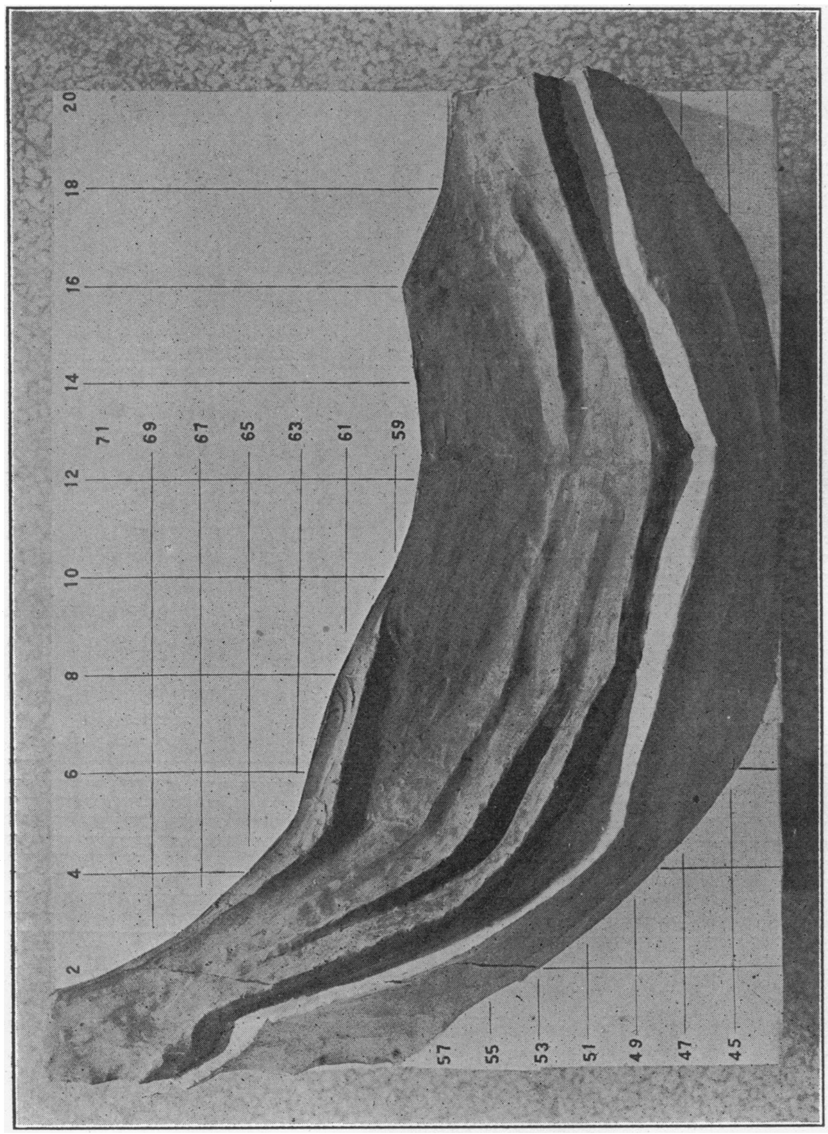


FIGURE 3

Photograph of a solid figure (model) giving the distribution of relative chest girth for various ages from birth to 20 years reading from left to right. The mean index of build at each age is centered on the curve of development of relative chest girth (Fig. 2). The relative chest girth is indicated in percentages passing from the bottom to the top of the figure. The solid figure is illuminated from the upper part of the photograph.

rise slightly up to 50 years of age. If the variability curve as found for the adult (figure 1) is determined also for all ages of the developmental curve; or, in other words, if the variability polygon be passed along the developmental curve changing its form appropriately at each age, then there will be generated the solid of which the airplane view is given in figure 3. In this figure the source of light is from in front. An examination of figure 3 shows the persistence from birth to maturity of the two main ridges. The lower one is probably made up of those individuals who belong, for the most part, to the biotype of medium build. The upper ridge includes very largely heterozygous individuals, progeny of fleshy and slender strains which show a considerable dominance of fleshiness over slenderness. Accessory ridges also appear suggesting the presence of slender and fleshy biotypes. The figure shows also differences in

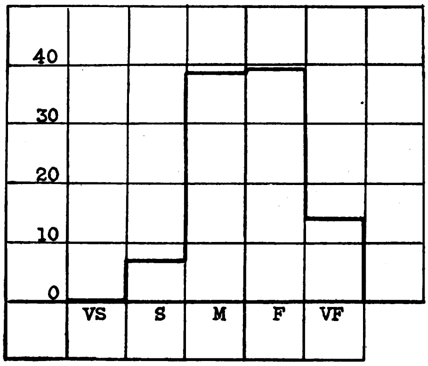


FIGURE 4

Polygon of percentage distribution of indices of the build of the 5 classes (very slender, slender, medium, fleshy and very fleshy) when both parents are of slender build.

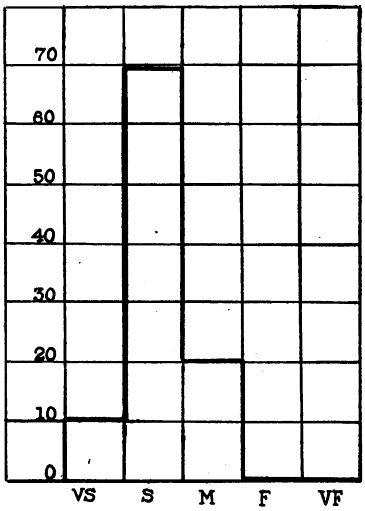


FIGURE 5

Polygon of distribution of percentage frequency of indices of build of offspring of parents who are both of fleshy build distributed in the same 5 classes as in figure 4.

variability of relative chest girth at different ages, but the restriction in variability at the extreme right of the figure is partly due to the fact that only soldiers were measured for this age. Hence it was a selected lot in which the extremes had been rejected.

Evidence of heredity is found in the fact that members of one family frequently undergo similar changes in build throughout middle life. It is found also in pedigrees of familial obesity. Mass studies of the distribution of the 5 classes of build in the progeny of various matings show a difference in distribution, in means and in variability as measured by the standard deviation or the coefficient of variability, figures 4 and 5. This greater variability in the progeny of fleshy as compared with slender parents is still shown even whenever allowance is made for the slightly greater range of classes of build covered by the term fleshy, as compared with the term slender.

Finally, analysis by modern genetical methods leads to the conclusion that there are generally two or more genetic factors involved in build. There are, however, biotypes in which only one factor is involved. Markedly is this true of the biotype of medium build. The factors for fleshy build dominate slightly over those for slender build.

A BOHR-LANGMUIR TRANSFORMATION

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1. *Equivalence.*—Two canonical systems, with coördinates and momenta

$$q_1, q_2, \ldots, q_k, \; p_1, p_2, \ldots, p_k; \qquad Q_1, Q_2, \ldots Q_k, \; P_1, P_2, \ldots, P_k$$

respectively, and energy functions

$$H = E_{\text{kin}} + E_{\text{pot}}, \qquad K = E'_{\text{kin}} + E'_{\text{pot}}$$

will be considered as equivalent for the purpose of this exposition, if

$$Q_i = \Phi_i(q_1, \ldots, q_k, \; p_1, \ldots, p_k) \qquad P_i = \Psi_i(q_1, \ldots, q_k, \; p_1, \ldots, p_k), \quad (1)$$

provided that the quantity $\Sigma(P_i\delta Q_i - p_i\delta q_i) = \delta W$ (1′)

can be shown by means of the equations of transformation to be the exact differential of some function $W(q_1, \ldots, q_k, p_1, \ldots, p_k)$. It is a consequence of the transformation that $K = H + \theta(t)$, where $\theta(t)$ is arbitrary and may be put equal to zero without loss of generality.[1]

This is a principle of relativity which is inherent in the classical dynamics. In fact, just as in the more modern theories of relativity natural coördinates and natural frames of reference are only approximately determined, so that within narrow limits a very wide range of theoretical possibility is opened, so also here there is arbitrariness in the naming of events in a dynamical process, for within certain limits of observation which